No. XII.

TRIPLET FOR A MICROSCOPE, &c.

The LARGE SILVER MEDAL *was presented to Mr. J.* HOLLAND, *6, Manor Place, Walworth, for his Microscopic Triplet and Doublet; from whom the following communication has been received.*

BY the following combinations of good double and plano-convex lenses in common use, the principal desiderata in the optical part of a superior general microscope are obtained; viz. extreme defining power, with good light, and sufficient magnifying power to bring out and beautifully define (even when the compound body is used) those most difficult test objects, the parallel lines upon each scale from the podura, and upon the diamond-beetle (the former as a transparent object, and the latter as an opaque one), which is not usually effected by the achromatic microscopes, notwithstanding the high cost at which they are necessarily furnished, arising from the difficulty in constructing them.

The *Triplet* is formed with three plano-convex lenses, having their plane sides towards the object.

No. 1, The lens next the object.
2, The middle lens.
3, The upper lens.

Nos. 1 and 2 require to be thin, and to be set as close together as possible, without being in contact; the focus of No. 2 to be rather longer than that of No. 1. The upper lens, No. 3, must be placed at some distance from

No. 2, in order to effect the proper correction; consequently the magnifying power of Nos. 1 and 2 will be diminished by No. 3, the focus of which must be at least twice that of No. 1. A diaphragm is to be placed between Nos. 2 and 3, the aperture in which is regulated by its distance from either of the lenses, diminishing in diameter in proportion as it is nearer to No. 2.

The beautiful effect of this combination principally depends upon the due distance between the middle and upper lenses, and upon the aperture in the diaphragm between them, joined to the truth and general perfection of all the lenses. These particulars are best found by trial, and the reason is obvious, for it is very difficult to make such small lenses quite alike in focus and thickness; but the circumstance is unimportant, provided the distance in each set of lenses be correctly adjusted in conformity to their relative foci.

The triplet, to be efficient (for the podura, &c.), should be equivalent in power to a single lens of one twenty-fifth of an inch focus; to produce which, the two lenses next the object must be very minute, to compensate for the diminution of power occasioned by the third lens.

This combination necessarily draws the object very close to the lens No. 1, consequently, if talc is used to cover the object, it must be very thin; it can be made sufficiently so without difficulty; in proof of which I may refer to some of my slides, the objects upon which are covered with talc, and yet are reached by a sphericle of $\frac{1}{300}$th of an inch focus. Should the proximity of the object to the lowest lens of the triplet be urged as a material objection to its usefulness, it may be answered, that the whole microscope is a mass of delicacies; conse-

quently it cannot be allowed that a line be arbitrarily drawn beyond which every thing is to be considered as *too* delicate.

The *Doublet* has a deep power, principally for opaque objects.

The optical part of this power is composed of one lens for magnifying and one for diminishing, upon Wollaston's principle, except that a diaphragm is added. The preceding remarks with regard to distance, relative foci of the lenses, and aperture in the diaphragm, equally apply here. The lower part of the cells for this doublet should be an inverted cone, the lens next the object just occupying its apex, by which contrivance all impediment is removed when the light is required to be thrown upon an opaque object. As a deep power, for the lines upon the scales of the diamond-beetle, &c., the focus should not be longer than one-twelfth of an inch: all the lower powers which are usually applied to a general microscope may be constructed upon the same principle, and will be found to act better than single lenses.

The Compound Body.—The only variation I have made is in the distance between the eye and field-lenses, which I increase to the sum of their foci, instead of half that distance; the latter being the usual mode of constructing a negative eye-piece. By this increase of distance, light and defining power are gained, although magnifying power and the field of view are diminished; but at the same time the latter is rendered very perfect. To remedy any inconvenience which the smallness of the field might occasion, the body must be so constructed as to allow a spare eye-piece (upon the usual construction) to be substituted when low objective powers are used

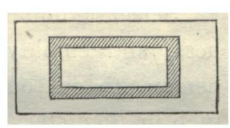
upon objects which are less critical than those for which the superior defining power of the improved eye-piece may be required.

Objects hermetically sealed in slides.

By the following mode objects in fluid (such as the active molecules composing gamboge, and similar objects) may be hermetically sealed in a microscopic slide. I have a slide of this description which was sealed on the 9th of June, 1829, and which yet remains perfect.

The cement which I use consists of the best white lead, worked up with one part linseed oil, and three parts spirit of turpentine. It must be worked for a long time with a palette-knife, upon a polished piece of marble, and made sufficiently thin to be laid on with a camel-hair pencil.

Take some pieces of flat glass, of the required size, and inclose a space thus, upon each, with one coat of the cement: this will form what is called in the microscopic world a pond. Although for these



minute objects depth is not necessary, yet, by proceeding in this way, the external coat of cement is prevented entering between the glass and talc, and mixing with the object. These glasses being so prepared, and being dry and hard, put, with the head of a pin, &c., a small drop of the fluid containing the object to be preserved, in the centre of the inclosure, upon which drop a piece of very thin and clear talc, the edges of which must rest upon the coat of cement, without extending to its outer margin. The talc will spread out the drop to almost an indefinite thinness; but care must be taken that the drop be not in sufficient quantity to touch the

inner margin of the cement. *That* being accomplished, take some almond oil in a hair pencil, and pass it lightly and slowly round the edges of the talc: the oil will insinuate itself under it, and will surround the object without mixing with it. After cleaning off any of the oil which may be beyond the talc, proceed to lay a coat of cement (still to be sufficiently thin) round the edges of the talc, extending about one-tenth of an inch within and without it. When dry and hard, the object will be effectually sealed, unless any flaw should exist in the talc.

Other objects which require some slight depth in the pond, may be treated in the same manner, having previously laid several coats of the cement upon each other in the *first* part of the process; but for such objects as require comparatively considerable depth, such as water-insects and larvæ, the chara translucens and vulgaris, &c. &c., proceed as follows :—

Select a number of pieces of glass of different thickness, and employ a seal-engraver, or other competent person, to cut out a circle (or core), of about $\frac{3}{4}$ of an inch in diameter, from part of them; from the remainder let circles, which will fit into the preceding, be cut out and cemented into them by the same parties, who have a cement proper for the purpose: it is manifest that, by varying the relative thickness of the glass used, cavities of different depths will be procured. When these pieces of glass, so prepared, are quite dry and hard, by filling them with water, introducing the object to be preserved, and covering them with talc, as before, they may be hermetically sealed, as already described.

Chara to vegetate in a Slide.

It is probable that a small and convenient shoot of the chara being mounted with water in one of these pieces of glass of a proper depth, and merely covered with a piece of talc, having a small perforation opposite to the edge of the cavity, will continue to vegetate until it occupy the whole cavity, and form an interesting subject for examination by deep powers, and possibly, by its gradual developement, the proximate causes of the circulation, which attracts so much attention, may be discovered.

The perforation in the talc is required in order to introduce, with a camel-hair pencil or other means, fresh water as evaporation proceeds; when full of water, if the perforation be covered, by dropping another very small piece of talc over it, the evaporation will be less rapid.

I may further state, that I use direct light (excluding the mirror) for the examination of transparent objects; and condensed direct light for that of opaque objects, which I find superior to light reflected from the speculum.

Reference to the Figures, Plate V., figs. 1, 2, 3.

Fig. 1 is the compound body of the real size, with the objective doublet attached. As the eye-piece is suited to receive parallel rays, this doublet requires to be at the same distance from the object, to suit the eye-piece, as it does to suit the eye alone; consequently, the adjustment of the lenses and diaphragm which makes it best when alone, also makes it best when used with the eye-piece. The central pencil of light *a*, and the two extreme pencils *b b*, are drawn to shew that the diaphragm prevents any

rays from passing but those which are equally balanced; and it makes the aperture for each pencil very small, by which there is little or no colour shewn.

Fig. 2 is a larger view of a doublet, with only the outside pencils *b b* drawn; *c* is the object: here it will be seen, that the pencils which pass through the lower lens at one side of its axis, pass through the upper lens on the contrary side; therefore, the portions of the two lenses which are used for each pencil may, by the adjustment of the stop or diaphragm, be such as shall correctly balance each other, and thus make the lateral rays pass nearly as perfect as the central pencil.

Fig. 3 shews the lenses of a triplet five times larger than their real size; the focus of each lens is marked near it.

In figs. 1 and 2 there is a stop *d* above the doublet or triplet, when the compound body is used; this helps more perfectly to darken the tubes, by stopping false or useless rays. The stop *e e* in the eye-piece is placed where the two foci meet, and the image is formed: it is too open in the drawing for the convenience of disposing the pencils; in practice it must be a little more than $\frac{1}{4}$ of an inch.